
Space Weather Technical Forecast

Issued on Tuesday, 30 August 2022 at 00:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of further M-flares (R1-R2 Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate, with five M-class flares, all from AR3088 which has now rotated off the SW limb, although some magnetic looping remains visible. Peak flare was an M8.6 at 29/1107 UTC. There are two active regions left on the disc, with AR3089 Ekc/Delta the most prominent. This is a large region in the central southern disc, but has remained inactive during the last 24 hours, only showing slow growth in its penumbral area and maintaining a small but persistent delta spot. The other region AR3085 is small, simple and declining, although is of some interest due to its development within northward extension of the southern crown coronal hole, CH17/-. No Earth-directed CMEs are evident on available imagery, however a filament eruption was observed just to the northwest of AR3089 at around 29/1415 UTC.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, showed the glancing arrival of a CME, likely alongside ongoing influence of the fast wind of CH17/-. The CME arrival at 29/0256 UTC, only increased speeds from 420 km/s to 460 km/s, before a further increase to elevated levels, around 500-540 km/s occurred around 29/0900 UTC. The density was mainly at average, but peaked above average at near 20 ppcc shortly after the CME arrived. The Interplanetary Magnetic Field (IMF) strength, Bt, rose from 5 nT to 10-12 nT at the same time, then varied between 5-12nT. The north-south-component Bz, briefly peak -10 nT just after the CME arrived, but became mainly positive (northward) varying between -7 nT and +8 nT. Phi angle remained mainly negative (towards the Sun). Geomagnetic activity was mainly Quiet to Unsettled, with one Active interval 29/0300-0600 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV), as measured by GOES- 16 was slightly elevated at first, but remained below S1/Minor Radiation storm levels and eased back towards background. The high energy electron flux (greater than 2 MeV) remained at Background levels. The 24-hour integrated electron fluence remained below the Active threshold (1e8 integrated pfu) with 1.09e6 integrated pfu observed at 30/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Current Moderate activity is expected to ease, with AR3088 no longer on the Earth-facing disc. However the large size of AR3089, along with it containing a delta spot, gives an ongoing chance of Moderate activity continuing, and a slight chance of High activity. This is despite its current minimal activity level

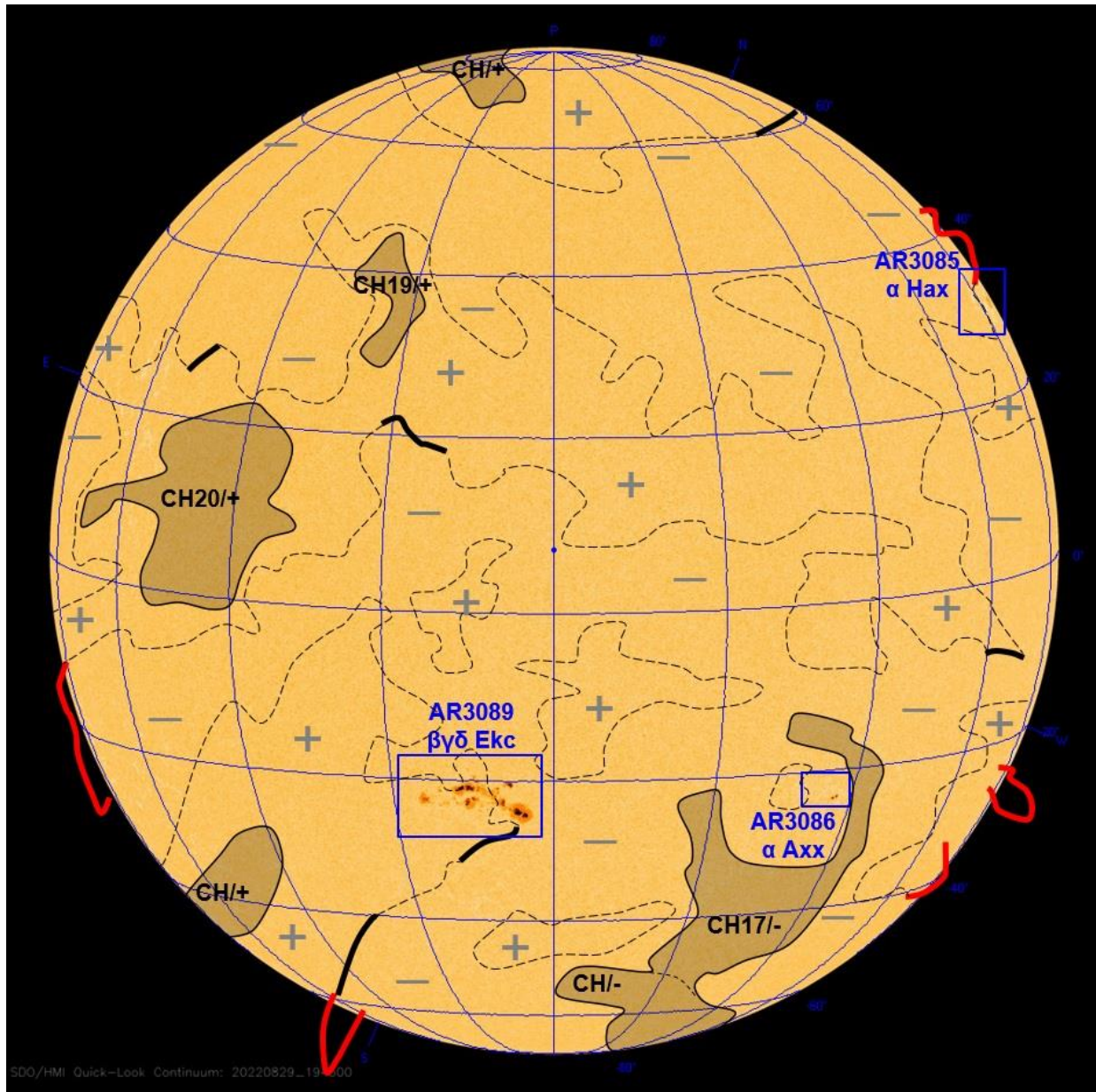
Solar Wind / Geomagnetic Activity: There are currently no Earth-directed CMEs, however there is some uncertainty due to the filament eruption in the centre disc on the 29th. Current elevated solar winds, likely due to the fast wind of CH17/- are expected to gradually ease with no other significant enhancement forecast. Geomagnetic activity is currently expected to be mostly Quiet with isolated Unsettled spells, mainly at first, and slight chance of Active intervals early day 1 (30th)

Energetic Particles / Solar Radiation: High energy protons (greater than 10MeV) are expected to remain slightly elevated but below the S1/Minor Radiation storm levels, with a chance of

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further enhancements, mainly from any notable flares from AR3088 days 1 and 2 (29th and 30th), but perhaps also AR3089, especially as it moves into the western disc. The high energy (greater than 2 MeV) electron flux forecast is expected to remain mostly at background, but perhaps rising to moderate with a slight chance of peaking at high, as current fast winds ease. The associated 24 hour fluence is now expected to remain below the Active threshold.

Figure 1. Solar Analysis Valid 29/2000 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

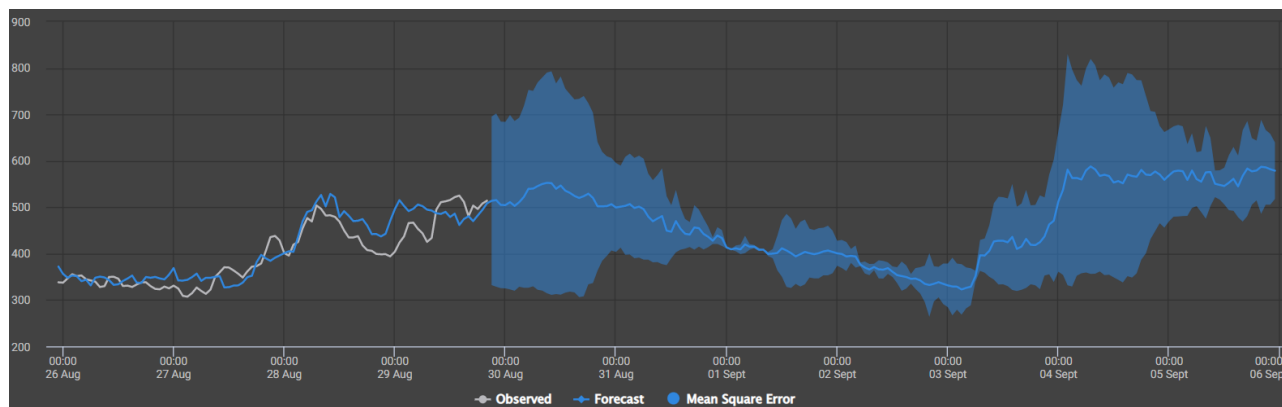
There are currently no Earth-directed CMEs, however there is some uncertainty due to a filament around 29/1415 UTC in the southern centre disc, which has yet to show a subsequent CME on available imagery.

Earth is likely within the fast wind of CH17/- with elevated wind speeds. These are expected to gradually ease falling to background by day 3 (1st). The next enhancement, likely from CH19/+ is not expected until at least the end of day 5 (3rd), beyond this forecast period. This is supported by 27-day persistence, which is currently giving good guidance.

Geomagnetic activity is currently expected to be mostly Quiet with isolated Unsettled spells, mainly at first, and slight chance of Active intervals early day 1 (30th).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Solar wind persistence Model



Radio Blackouts - X-Ray Flares:

Solar Activity has been Moderate for a number of days as active region AR3088 moved across the southwest disc. This has now rotated over the southwest limb, however, and any further significant flares from this region are now increasingly unlikely to be observed on the Earth-side.

There are only two active regions now on the Earth-facing disc. The most prominent is the large southern-central disc region AR3089 Ekc/Beta-gamma-Delta. This was the source of 2 R2 radio blackouts (M5+ flares) on the 26th, but then simplified briefly, before increasing in complexity again with the development of a persistent delta spot. However, the spot itself has remained inactive with no further significant flaring observed, with only limited E-W aligned magnetic looping evident. As this continues to grow, this may increase in complexity, but currently brings only a chance of M-flares and a slight chance of X-flares. The other region AR3086 Axx/alpha, which developed amongst CH17/- in the south, is very small unipolar spot, and gradually declining.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	30	30	30
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3a: GOES-16/17 X-ray Flux

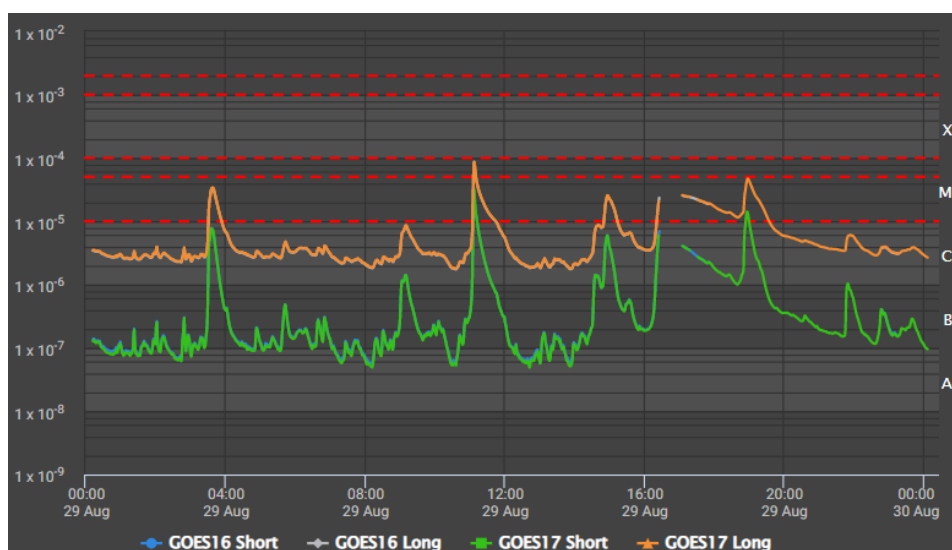


Figure 3b: SDO Intensitygram (top) and Magnetogram (bottom) of AR3089

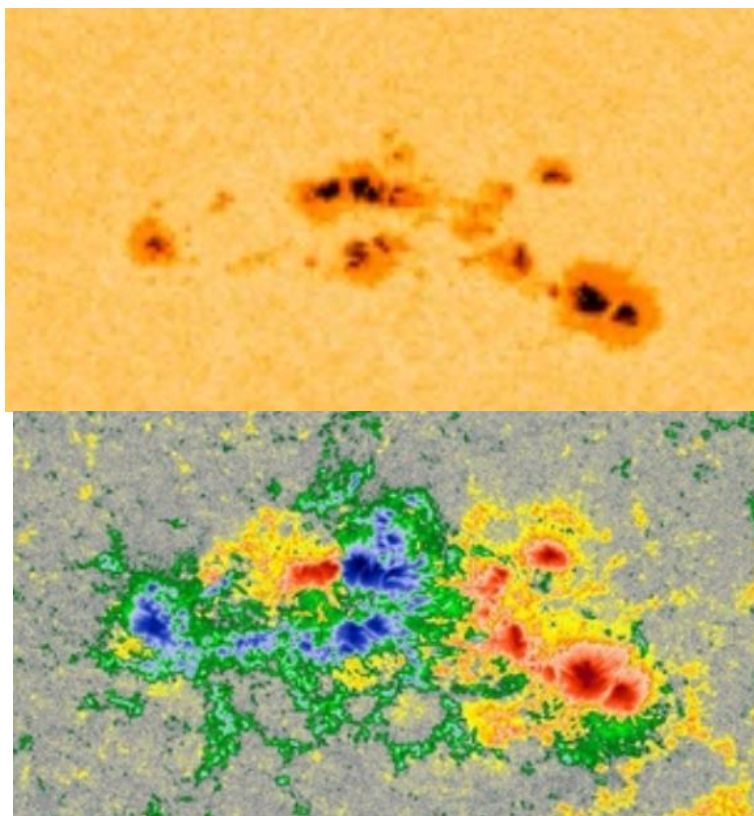
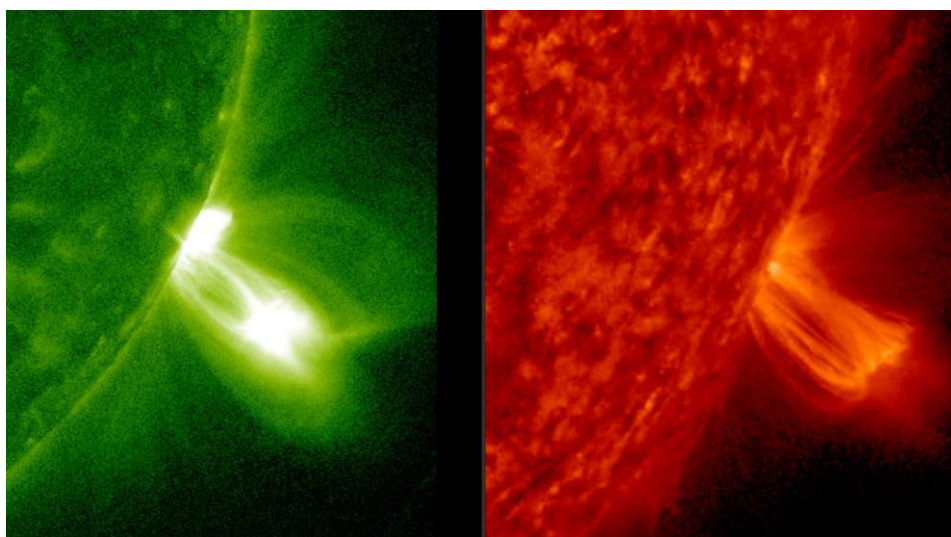


Figure 3c: SDO aia-94 and aia 304 showing looping of AR3088 still visible over the limb





Solar Radiation Storms - (High Energy Protons):

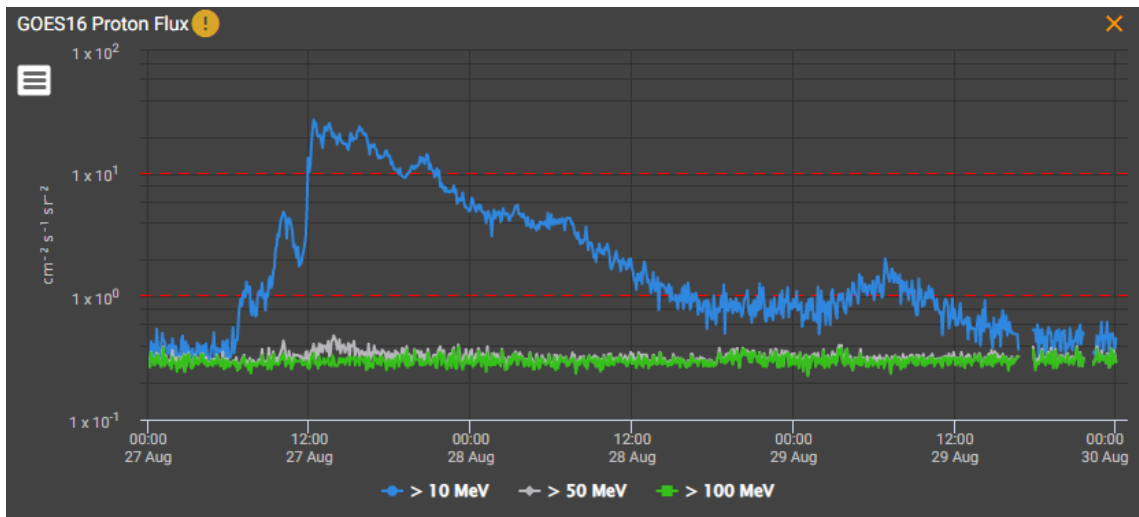
The high energy (greater than 10 MeV) proton flux as observed by GOES-16 is currently just above background levels after recent enhancements, but is likely to continue to ease. There is just a slight chance of rising above the S1 level, most likely on day 1 or 2 (30th or 31st), mainly due to the ongoing flaring of AR3088.

AR3088, despite being past the limb, still has the potential to increase the proton flux at Earth, should it produce a notable flare, although this risk is decreasing as it continues to rotate away. Although the flaring observed on the 28th and 29th has not produced a significant proton response, suggesting similar flares from this region are unlikely too. AR3089 is also now moving into the western hemisphere, making any proton rich flares more likely to be geoeffective, although this spot has been stable since its previous two R2 flares the 26th.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)

Figure 4: GOES-16 Proton >10MeV, >50MeV and >100 MeV Flux (for last 3 days)



High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy electron flux (greater than 2 MeV) as observed by GOES-16 is currently at background. Solar winds are currently enhanced, likely by CH17/- fast wind and as this recedes there is a chance for the flux to rise to Moderate, with a slight chance of reach high at any diurnal peak. On the previous 27-day rotation, this fast wind resulted in very little enhancement to electron numbers however, suggesting that only a limited enhancement can be expected on this rotation too.

The associated 24 hr fluence is forecast to remain below the Active ($1\text{e}8$ integrated pfu) threshold through the period. This is supported by REFM, which despite overestimating values, is now giving good guidance with a steady trend throughout.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	1	1
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: GOES-16 Electron Fluence with REFM

